LCI Lake Water Quality Summary

General Information

Lake Name: Highland Lake

Location: Town of Highland, Sullivan County, NY
Basin: Delaware River Basin
Size: 80.3 hectares (198.3 acres)
Lake Origins: natural
Major Tributaries: minor unnamed tributary
Lake Tributary to?: Halfway Brook via a minor unnamed tributary
Water Quality Classification: B (best intended use: primary contact recreation)

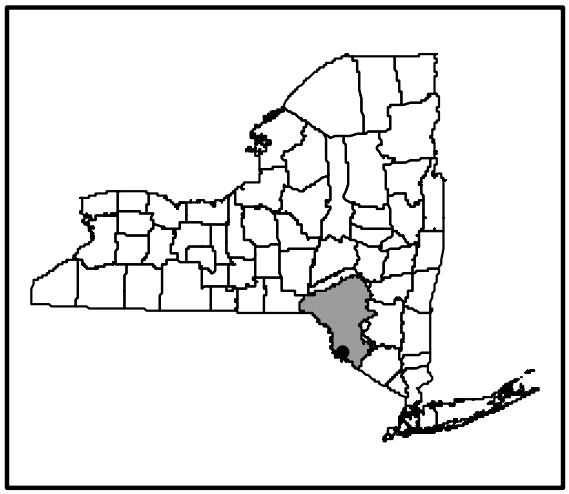
Sounding Depth: 6.0 meters (19.5 feet)
Sampling Coordinates: Latitude: 41.52748, Longitude: -74.84955
Sampling Access Point: private land (Susan Vorstat)

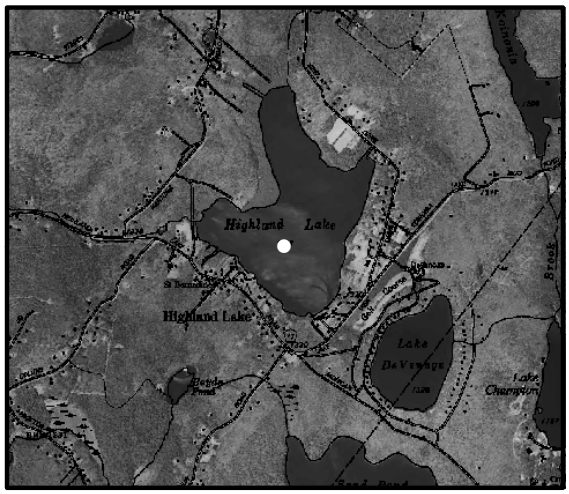
Monitoring Program: Lake Classification and Inventory (LCI) Survey
Sampling Date: July 29, 2009
Samplers: David Newman, NYSDEC Division of Water, Albany
Steven Finnemore, NYSDEC Division of Water, Albany

Contact Information: David Newman, NYSDEC Division of Water
djnewman@gw.dec.state.ny.us; 518-402-8201

Lake Map

(sampling location marked with a circle)





Background and Lake Assessment

Highland Lake is one of several lakes in the Town of Highland Lake in the lake pocketed region of Sullivan County. The immediate shoreline area of the lake is developed with single family homes. The lake currently supports swimming, fishing and boating. Highland Lake was included in the NYSDEC Division of Water's 2009 Lake Classification Inventory (LCI) survey in the Delaware River Basin. Inclusion in the LCI's screening year (single sample) was based on a lack of water quality information from the lake in the Division of Water's database.

Highland Lake can generally be characterized as *eutrophic,* or highly productive. The water clarity (TSI = 56, typical of *eutrophic* lakes) is expected given the chlorophyll *a* reading (TSI = 55, typical of *eutrophic* lakes), however it is lower than expected given the phosphorus reading (TSI = 43, typical of *mesotrophic* lakes). These data indicate that algae levels were elevated; however, baseline nutrient levels do not support persistent algal blooms. The water clarity reading may have been artificially low due to the windy and cloudy conditions on the lake, making it hard to get an accurate water clarity reading.

The lake was observed to have a tea-like color, which was common among other lakes sampled in the area. This color comes from weak organic acids (tannins) that enter the lake through the watershed. However, the true color reading was low, indicated that the lake was weakly colored and that the tannins probably are not a big influence on the water clarity. Several native species of rooted aquatic plants were found on the lake and included three floating leaf plants—*Nuphar microphylla* (small yellow pond lily), *Nymphaea sp.* (white water lily), and *Nuphar sp.* (yellow water lily)--and *Myriophyllum humile* (low watermilfoil), a submergent native milfoil. No exotic invasive species were found; however, a more thorough plant specific survey would need to be conducted to completely rule out their occurrence.

Highland Lake exhibits thermal stratification, in which depth zones (warm water on top, cold water on the bottom during the summer) are established, as in most NYS lakes great than six meters in depth. The thermocline in the lake was in the three to four meter depth range. The entire hypolimnion (bottom waters) was anoxic (devoid of oxygen) at depths below four meters. This is typical of lakes with high chlorophyll *a* (algae) readings and was common among other lakes sampled in the area. pH readings indicate slightly acidic waters and conductivity readings indicate moderately soft water, both indicative of normal conditions in the Delaware River Basin. The oxygen reduction potential (ORP) readings were well below zero in the hypolimnion, indicating persistent oxygen deficits.

The lake appears to be typical of soft water, weakly colored, slightly acidic lakes. Other lakes with similar water quality characteristics often support warmwater fisheries, although fisheries habitat cannot be fully evaluated through this monitoring program. Coldwater fisheries are unlikely to be supported, given the lack of cold water and high oxygen refugia necessary to protect any salmonids or aquatic life susceptible to high summer temperatures. It is not known if these coldwater fish have historically been supported in the lake.

Nitrate and ammonia levels were low both in the surface and bottom waters. Total phosphorus levels were in the mid range in the surface waters and slightly elevated in the bottom waters. Soluble phosphorus levels were low in the surface water, indicating that most of the available

phosphorus is already tied up in primary production. The nitrogen and phosphorus ratio indicated that, like most lakes, phosphorus is the limiting nutrient, so any phosphorus addition to the lake will likely increase the production of algae. Chloride levels were found to be in the moderate to high range, indicating impacts from road salting and/ or stormwater runoff through developed areas. Iron and manganese levels were elevated in the bottom waters, common among lake exhibiting deepwater oxygen deficits.

Evaluation of Lake Condition Impacts to Lake Uses

Potable Water (Drinking Water)

Highland Lake is not classified for use as a potable water supply. Although the LCI data are not sufficient to evaluate potable water use, these data suggest that surface waters may require substantial treatment due to elevated levels of algae. Deep intakes of lake water would require substantial treatment to serve as a potable water supply, due to the high levels of iron and manganese.

Contact Recreation (Swimming)

Highland Lake is classified for contact recreation- swimming and bathing. It would appear the lake currently supports this use. Bacteria data are needed to evaluate the safety of Highland Lake for swimming, however these are not collected through the LCI. The water clarity reading was just above the New York State Department of Health's standard for protecting the safety of swimmers. It is expected that that the water clarity reading may have been artificially low due to weather conditions, although any increases in algae levels may drop the water clarity reading below the state minimum to protect the safety of swimmers.

Non-Contact Recreation (Boating and Fishing)

Many boats (motorized and self powered) were observed on the lake as well as docked on the shore of the lake, suggesting that this use is currently supported. The data collected through the LCI indicates that this use should continue to be supported.

Aquatic Life

The anoxic conditions in the bottom waters will stress aquatic life susceptible to high summer temperatures. Additional biological studies would be needed to fully evaluate any other stressors to aquatic life in the lake.

Aesthetics

These data indicate that aesthetics should be fully supported. Due to the large number of homes along the lake shore there may be times that the number and types of boats on the lake may detract from some lake residents' enjoyment of the lake.

Additional Comments

1. Periodic surveillance for invasive exotic plant species may help to prevent the establishment and spread of any new invaders, given the escalating problems with exotic aquatic weeds in area. Education of lake users to the risk of invasive species and proper cleaning and inspection of boats brought to the lake from other

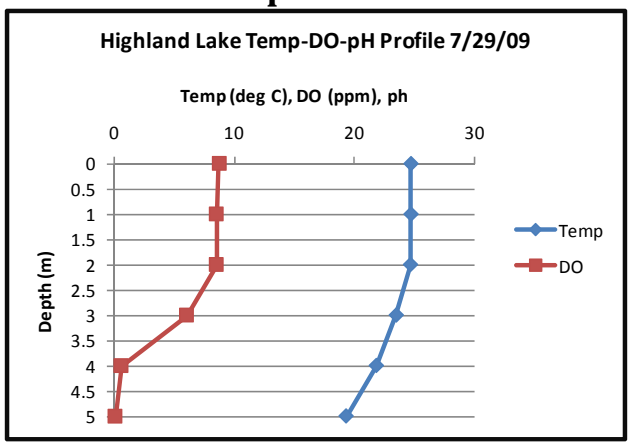
waterbodies will go a long way to help limit the importation of exotic species to the lake.

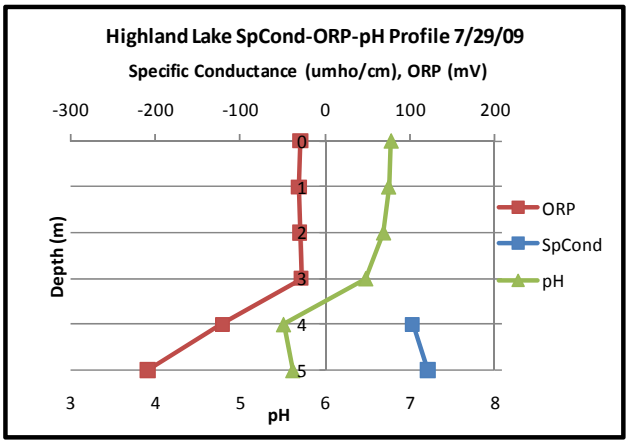
2. Algae identification would determine if the lake may suffer from harmful algal blooms (HABs) and/or the production of algal toxins. This may be conducted through future generation of the LCI.
3. Education of lake shore residence to not over fertilize lawns and regularly inspect septic systems may help minimize phosphorus inputs to the lake.

Aquatic Plant IDs

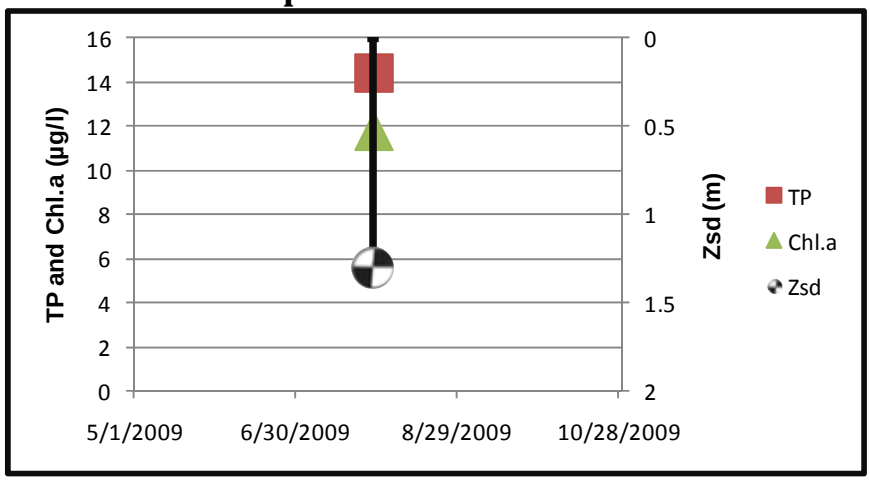
Exotic Plants:	None
Native Plants:	*Myriophyllum humile* (low watermilfoil)
	Nuphar microphylla (small yellow pond lily)
	Nuphar sp. (yellow water lily)
	Nymphaea sp. (white water lily)

Time Series: Depth Profiles





Time Series: Trophic Indicators



WQ Sampling Results

Surface Samples

	UNITS	Reading	Scientific Classification	Regulatory Comments
SECCHI	meters	1.3	Eutrophic	Readings does not violate DOH guidance value
TSI-Secchi		56.2	Eutrophic	No pertinent water quality standards
TP	mg/l	0.0144	Mesotrophic	Readings does not violate DEC guidance values
TSI-TP		42.6	Mesotrophic	No pertinent water quality standards
TSP	mg/l	0.0041	Little available phosphorus	No pertinent water quality standards
NOx	mg/l	0.0073	Low nitrate	Reading does not violate guidance
NH4	mg/l	0.013	Low ammonia	Reading does not violate guidance
TKN	mg/l	0.43	Low organic nitrogen	No pertinent water quality standards
TN/TP	mg/l	66.81	Phosphorus Limited	No pertinent water quality standards
CHLA	ug/l	11.8	Eutrophic	No pertinent water quality standards
TSI-CHLA		54.8	Eutrophic	No pertinent water quality standards
Alkalinity	mg/l	4	Poorly Buffered	No pertinent water quality standards
TCOLOR	ptu	15	Weakly Colored	No pertinent water quality standards
TOC	mg/l	6.2		No pertinent water quality standards
Ca	mg/l	4.47	Does Not Support Zebra Mussels	No pertinent water quality standards
Fe	mg/l	0.0858		Reading does not violate water quality standards
Mn	mg/l	0.107		Reading does not violate water quality standards
Mg	mg/l	1.07		Reading does not violate water quality standards
K	mg/l	0.549		No pertinent water quality standards
Na	mg/l	16.6		Reading does not violate water quality standards
Cl	mg/l	30.9	Significant road salt runoff	Reading does not violate water quality standards
SO4	mg/l	4.6		Reading does not violate water quality standards

Bottom Samples

	UNITS	Reading	Scientific Classification	Regulatory Comments
TP-bottom	mg/l	0.0233		No pertinent water quality standards
TSP-bottom	mg/l	0.0081	High % soluble phosphorus	No pertinent water quality standards
NOx-bottom	mg/l	0.0036	No evidence of DO depletion	Readings does not violate water quality standards
NH4-bottom	mg/l	0.016	No evidence of DO depletion	Readings does not violate water quality standards
TKN-bottom	mg/l	0.42		No pertinent water quality standards
Alk-bottom	mg/l	5.1	Poorly Buffered	No pertinent water quality standards
TCOLOR-bottom	ptu	20	Weakly Colored	No pertinent water quality standards
TOC-bottom	mg/l	5.5		No pertinent water quality standards
Ca-bottom	mg/l	4.47	Does Not Support Zebra Mussels	No pertinent water quality standards
Fe-bottom	mg/l	0.0858		Reading does not violate water quality standards

Bottom Samples (continued)

	UNITS	Reading	Scientific Classification	Regulatory Comments
Mn-bottom	mg/l	1.37	Taste or odor likely	Reading violates water quality standards
Mg-bottom	mg/l	1.1		Reading does not violate water quality standards
K-bottom	mg/l	0.591		No pertinent water quality standards
Na-bottom	mg/l	16.8		Reading does not violate water quality standards
Cl-bottom	mg/l	30.9		Readings does not violate water quality standards
SO4-bottom	mg/l	4.1		Readings does not violate water quality standards
As-bottom	mg/l	ND	No evidence of potable water threats	No reading violate guidance values

Lake Perception

	UNITS	Reading	Scientific Classification	Regulatory Comments
WQ Assessment	1-5, 1 best	3	Definite Algal Greenness	No pertinent water quality standards
Weed Assessment	1-5, 1 best	3	Plants Grow to Lake Surface	No pertinent water quality standards
Recreational Assessment	1-5, 1 best	3	Slightly Impaired	No pertinent water quality standards

Legend Information

General Legend Information

Surface Samples = integrated sample collected in the first 2 meters of surface water
Bottom Samples = grab sample collected from a depth of approximately 1 meter from the lake bottom
SECCHI = Secchi disk water transparency or clarity - measured in meters (m)
TSI-SECCHI = Trophic State Index calculated from Secchi, = 60 – 14.41*ln(Secchi)

Laboratory Parameters

ND = Non-Detect, the level of the analyte in question is at or below the laboratory's detection limit
TP = total phosphorus- milligrams per liter (mg/l)
Detection limit = 0.003 mg/l; NYS Guidance Value = 0.020 mg/l
TSI-TP = Trophic State Index calculated from TP, = 14.42*ln(TP*1000) + 4.15
TSP = total soluble phosphorus, mg/l
Detection limit = 0.003 mg/l; no NYS standard or guidance value
NOx = nitrate + nitrite nitrogen, mg/l
Detection limit = 0.01 mg/l; NYS WQ standard = 10 mg/l
NH4 = total ammonia, mg/l
Detection limit = 0.01 mg/l; NYS WQ standard = 2 mg/l
TKN = total Kjeldahl nitrogen (= organic nitrogen + ammonia), mg/l
Detection limit = 0.01 mg/l; no NYS standard or guidance value
TN/TP = Nitrogen to Phosphorus ratio (molar ratio), = (TKN + NOx)*2.2/TP

> 30 suggests phosphorus limitation, < 10 suggests nitrogen limitation

CHLA = chlorophyll *a*, micrograms per liter (µg/l) or parts per billion (ppb)
Detection limit = 2 µg/l; no NYS standard or guidance value

TSI-CHLA = Trophic State Index calculated from CHLA, = 9.81*ln(CHLA) + 30.6

ALKALINITY = total alkalinity in mg/l as calcium carbonate
Detection limit = 10 mg/l; no NYS standard or guidance value

TCOLOR = true (filtered or centrifuged) color, platinum color units (ptu)
Detection limit = 5 ptu; no NYS standard or guidance value

TOC = total organic carbon, mg/l
Detection limit = 1 mg/l; no NYS standard or guidance value

Ca = calcium, mg/l
Detection limit = 1 mg/l; no NYS standard or guidance value

Fe = iron, mg/l
Detection limit = 0.1 mg/l; NYS standard = 0.3 mg/l

Mn = manganese, mg/l
Detection limit = 0.01 mg/l; NYS standard = 0.3 mg/l

Mg = magnesium, mg/l
Detection limit = 2 mg/l; NYS standard = 35 mg/l

K = potassium, mg/l
Detection limit = 2 mg/l; no NYS standard or guidance value

Na = sodium, mg/l
Detection limit = 2 mg/l; NYS standard = 20 mg/l

Cl = chloride, mg/l
Detection limit = 2 mg/l; NYS standard = 250 mg/l

SO4 = sulfate, mg/l
Detection limit = 2 mg/l; NYS standard = 250 mg/l

As =arsenic, mg/l
Detection limit = 3.2 mg/l; NYS standard = 10 mg/l

Field Parameters

Depth = water depth, meters

Temp = water temperature, degrees Celsius

D.O. = dissolved oxygen, in milligrams per liter (mg/l) or parts per million (ppm)
NYS standard = 4 mg/l; 5 mg/l for salmonids

pH = powers of hydrogen, standard pH units (S.U.)
Detection limit = 1 S.U.; NYS standard = 6.5 and 8.5

SpCond = specific conductance, corrected to 25ºC, micromho per centimeter (µmho/cm)
Detection limit = 1 µmho/cm; no NYS standard or guidance value

ORP = Oxygen Reduction Potential, millivolts (MV)
Detection limit = -250 mV; no NYS standard or guidance value

Lake Assessment

WQ Assessment **= water quality assessment**, 5 point scale, 1= crystal clear, 2 = not quite crystal clear, 3 = definite algae greenness, 4 = high algae levels, 5 = severely high algae levels

Weed Assessment **= weed coverage/density assessment**, 5 point scale, 1 = no plants visible, 2 = plants below surface, 3 = plants at surface, 4 = plants dense at surface, 5 = plants cover surface

Recreational Assessment **= swimming/aesthetic assessment**, 5 point scale; 1 = could not be nicer, 2 = excellent, 3= slightly impaired, 4 = substantially impaired, 5 = lake not usable